Neuroplasticity: A Study to Understand the Formation of Neural Pathways When Learning a New Skill

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INTRODUCTION

www.diygenius.com/wp-content/uploads/2015/06/learning-and-neuroplasticity-in-the-brain.jpg

NEUROPLASTICITY:

The lifelong ability of the brain to reorganize itself as a result of experience

Can the brain be trained to become more efficient in learning a new skill? Do gender and athletic inclination affect the time it takes to acquire a new athletic skill? During the learning process, do new neural pathways develop or do old pathways transform? Measuring the change in the development of a skill during this cognitive training could be an indication of neuroplasticity. The study aims to understand key factors and duration that contribute to formation of neural pathways.

BACKGROUND AND SIGNIFICANCE

Based on preliminary research in Neuroplasticity, I have learned how the brain is able to change and adapt to learning new skills based on external experiences. To demonstrate the basics of neuroplasticity prior to my Ball/Target experiment, my grandmother and I performed an experiment where we each wrote the same paragraph with our dominant hand and non-dominant hand. We were not able to finish writing the paragraph with our non dominant hand within the given time, contrary to our dominant hand, which is used every day and neural pathways responsible for writing already exist. Although I was eventually able to finish the paragraph with my non-dominant hand after a few weeks of repetitive trials, my grandma showed few signs of improvement. This suggested that age is a likely factor for her taking much longer to develop new neural pathways. What interests me on this topic is the process of how neural pathways are created and destroyed as skills are learned and forgotten over time, respectively.

Significance:

My research is a stepping stone towards conducting further research in neuroplasticity with brain imaging. This may lead to discoveries on how external factors contribute to learning a new skill, specifically if athletic inclination is a prime factor, indicating that subjects who already play sports have the ability to rapidly adapt to changes in the brain that make it easier to acquire new athletic skills. These findings can be applied toward understanding degenerative diseases, such as Alzheimer's, where neural pathways are spontaneously destroyed.

RESULTS

Figure 1. Progression of Throwing Accuracy with Respect to Dominant versus Non Dominant Hand

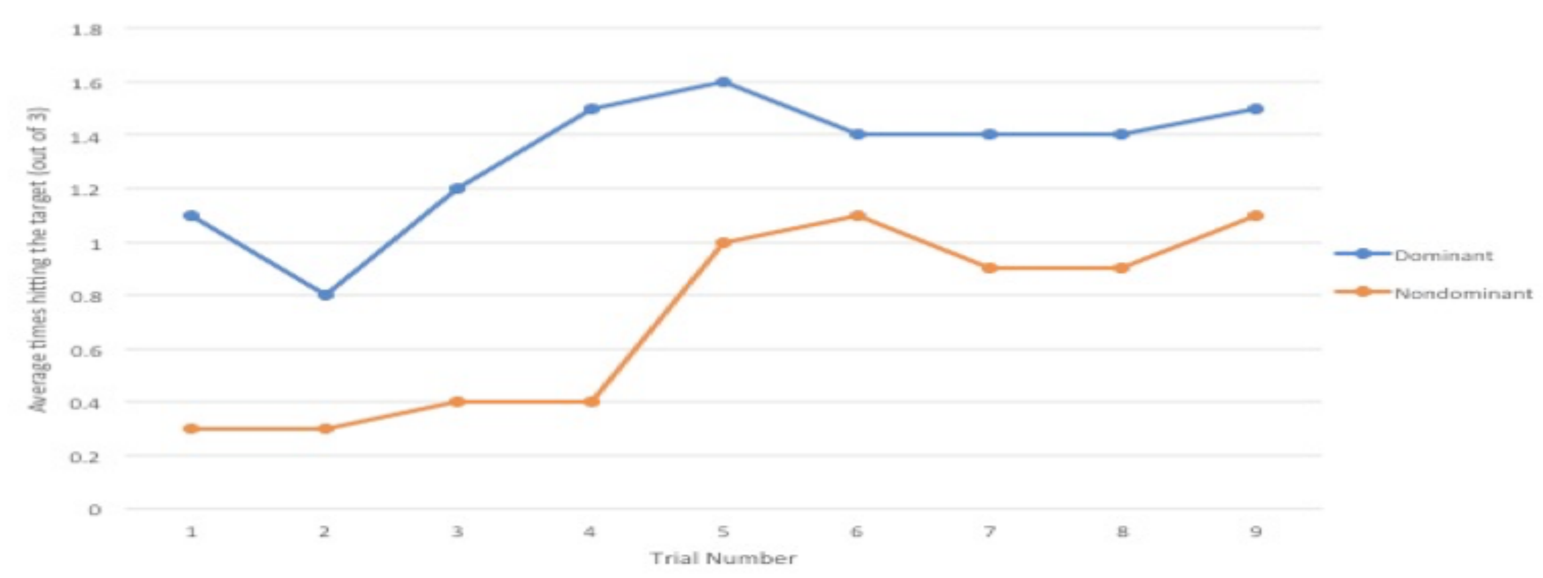


Figure 2. Progression of Throwing Accuracy with Respect to Dominant versus Non Dominant Hand and Gender

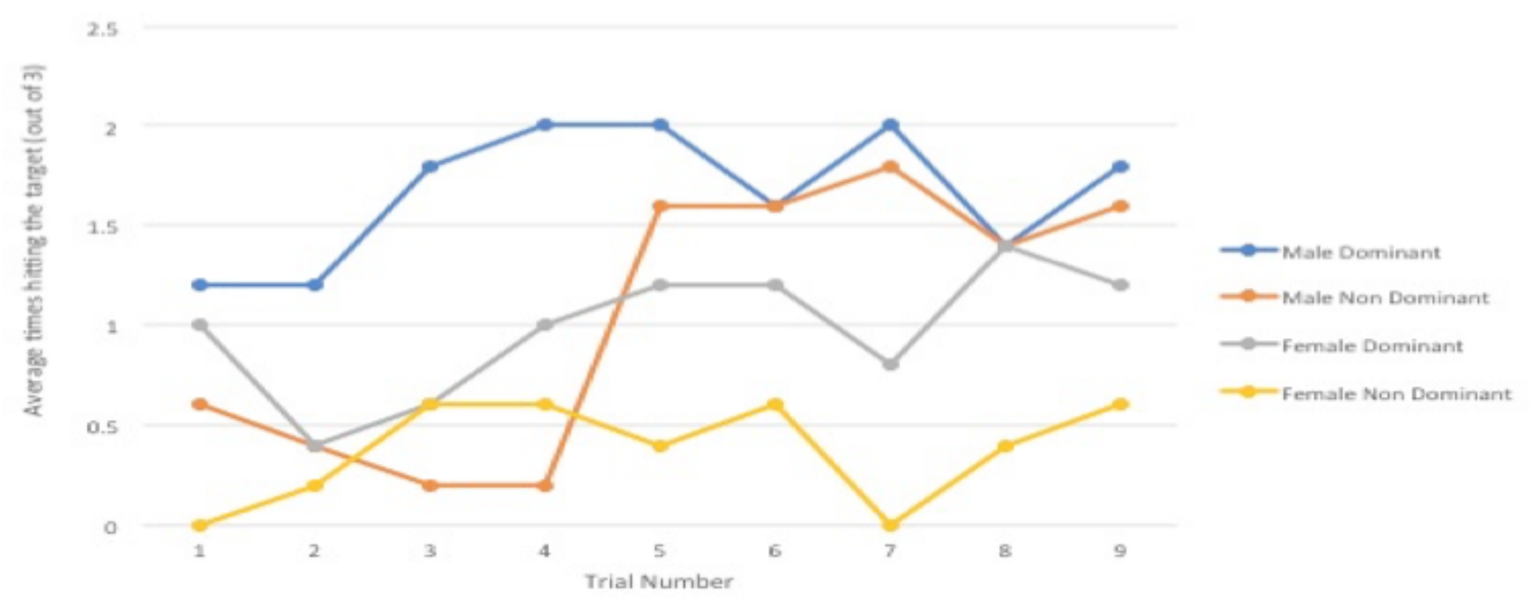


Figure 3. Progression of Throwing Accuracy with Respect to Dominant versus Non Dominant Hand and Athletic Inclination

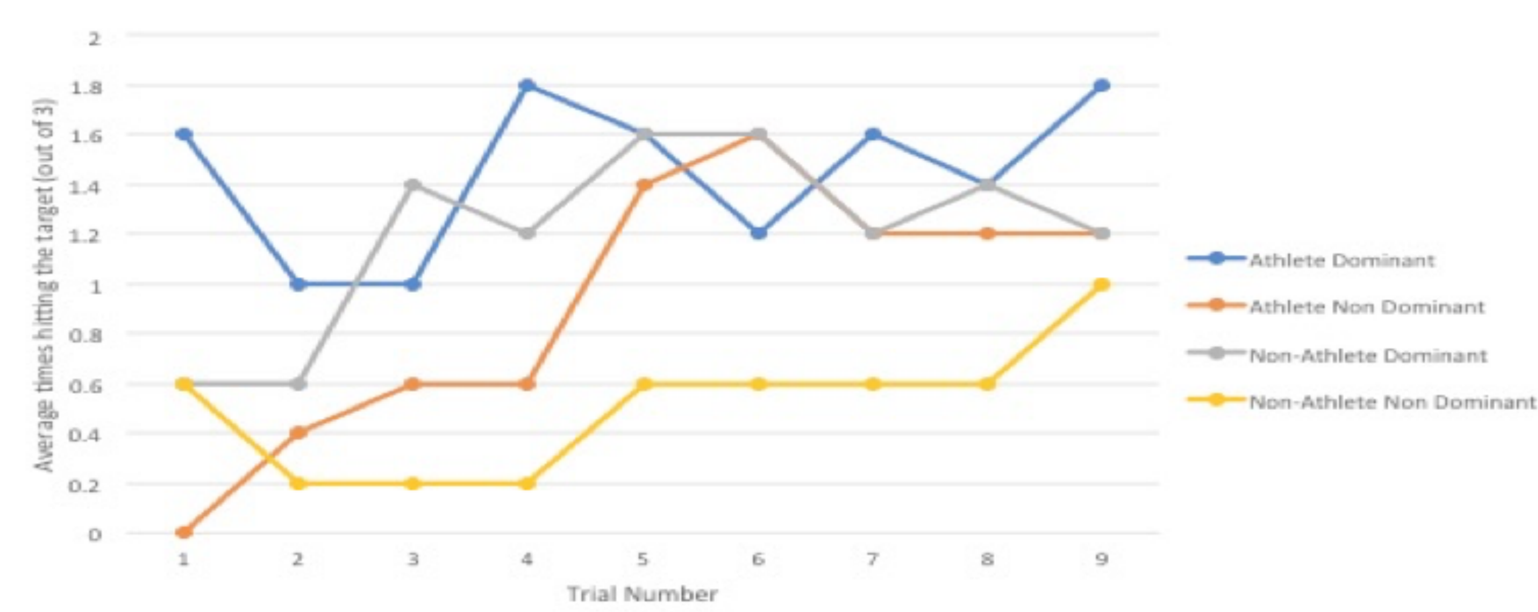
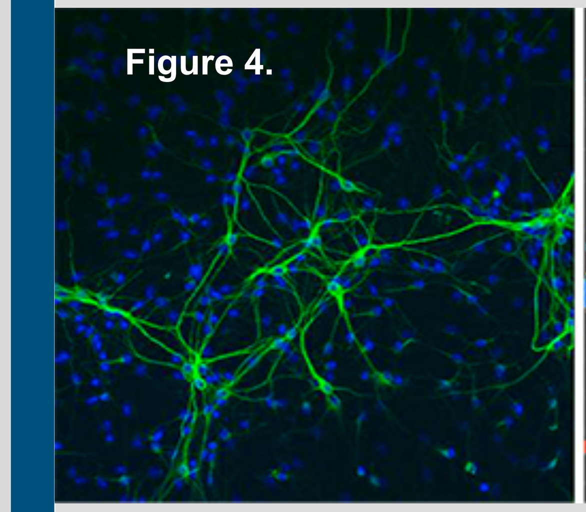
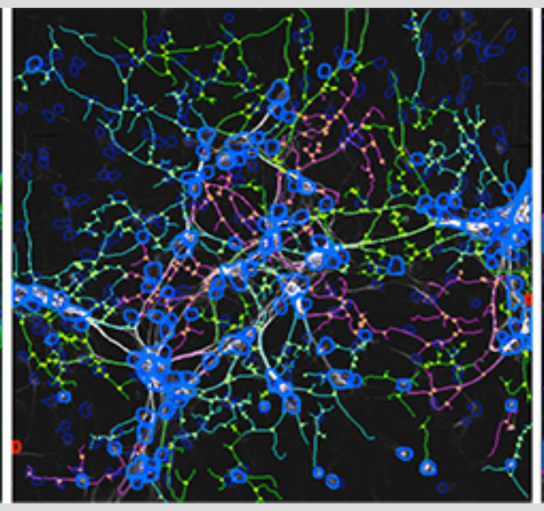
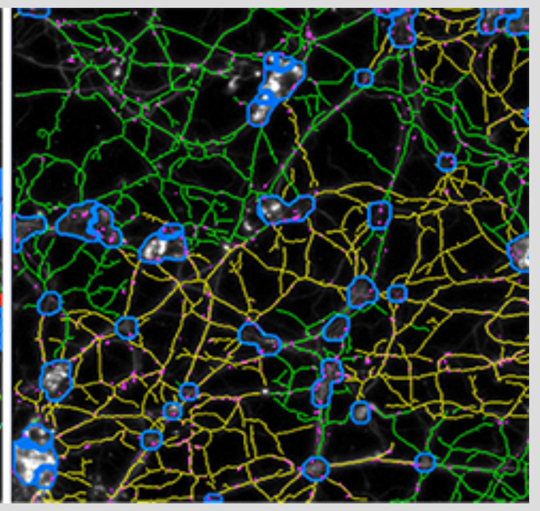


Figure 4.

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METHODOLOGY, ANALYSIS AND DISCUSSION

Materials:

Rectangular strike zone (18" x 24"), Racquet balls, Measuring tape, Data recording notebook

Methodology:

10 students (5 Male, 5 Female), average age 16.2, participated in 9 Trials using both dominant and non-dominant hands. 5 athletically inclined (3 Male, 2 Female) and 5 non-athletically inclined students (2 Male, 3 Female) from Gunn High School were recruited. Each subject threw a ball from 9 meters to a target three times with both the dominant and non-dominant hands. Results were recorded. There were 9 trials for each subject, 2-3 times per week for four weeks. The scores of the subjects were averaged and compared between gender and athletic ability.

Analysis:

1) *Entire Sample* (Figure 1): Starting with Trial 1, the average number of times the target was hit with the dominant hand (1.1) was greater than that of the non dominant hand (0.3). Results with the dominant hand consistently improved from Trial 2 to Trial 5, peaking at Trial 5 with an average hit rate of 1.6. Results with the non-dominant hand spiked from Trial 4 to Trial 6 averaging 1.1 at its peak. Subsequently, averages for both hands stabilized from Trial 6 until completion at Trial 9 with a steady difference of .4 between the 2 hands. This indicates that amongst the sample, performance of the dominant hand did not change, while that of the non-dominant hand improved, indicating that new neural pathways were formed, a process seen in Figure 4 (not experimental data).

2) *Gender* (Figure 2): With respect to gender, it appears that the male subjects exhibited similar behavior to that of the entire sample, with a Trial 1 difference between dominant (1.2) and non-dominant (0.6), with the difference tapering off after Trial 5. This indicates that in these male subjects, neural pathways were formed. Although males demonstrated the fact that the non-dominant hand caught up to the dominant, that wasn't the case for the females. However, different tasks may elicit different patterns of improvement between males and females. Further research is needed.

3) *Athletic Inclination* (Figure 3): While it appears that the dominant averages for athletic subjects is greater than that of non-athletic subjects, both of the non-dominant parameters increase at the same rate consistently and almost reach the same average hit rate (~1.1) by Trial 9. Also, it can be observed that at conclusion of the trials at Trial 9, athletic non-dominant reaches the same value as non-athletic dominant, about 1.2. This implies that the effect of athletic inclination is a contributing factor for the gap between the dominant and the non-dominant averages.

Future Work: To obtain a definitive conclusion of neural pathway formation, a brain imaging study is required on these subjects. However it is outside the scope of this study due to unavailability of an MRI. Another key finding that interests me is that cancer cells develop a lot slower in patients who have neurodegenerative diseases such as Alzheimer's. In these patients, the assumption is that neurons are less fluid, causing slower development of neural pathways, thereby slowing growth in cancer cells.

ACKNOWLEDGEMENTS / REFERENCES

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Works Cited:

1. Bartels, Laurie."Neuroplasticity and the Brain That Changes Itself. SharpBrains Inc., 2016. Web.
2. "Cognitive tutoring induces widespread neuroplasticity publishing Group, n.d. Web. 06 Nov. 2016.
3. "Sex Differences in Neuroplasticity in Humans." National Library of Medicine, 6 Nov. 2006. 25 Feb.
4. Peterson, Dan. "Neuroplasticity and the Athletic Brain (cont.)." Axon Sports, n.d. Web. 25 Feb.
5. Hosier, David. "RECOVERY: HOW THE BRAIN CAN 'REWIRE' ITSELF (
6. "Neuroplasticity: Rewiring Your Brain - Reset.me." Resetme. N.p., n.d. Web. 06 Nov.
7. Wilkinson, Andrea J., and Lixia Yang. "Inhibition Plasticity in Older Adults: Neural Plasticity 2016